## Background

**Social Sciences.** E. Rogers pioneering book on the social science of diffusion has seen five editions since 1962, and kicked off the development of this field [22]. This latest edition from 2003 gives a great overview of the social science perspective.

**Marketing.** This is the original 1969 paper that proposed the Bass Model [2] for understanding the diffusion of new products. It has been claimed that this model is the most popular model used in marketing. It's perhaps easier to read this retrospective written by Bass [3], or this earlier more detailed survey on the Bass Model [18]. I also mentioned the Bass-Norton model for successive generations of new technologies proposed in 1987 [20].

**Economics.** There are hundreds of papers on network externalities in economics, so I won't even try to cite all of them. It's generally agreed that the first papers in this area are by Katz and Shapiro in 1985 [17] and by Farrell and Saloner in 1985 [9]. I found Arun Sundararajan's webpage overview of the literature on network effects very helpful [25]. See also Rysman's review of two sided markets [23]. In the tutorial I went into detail on Farrell and Saloner's 1986 paper on the adoption of incompatible technologies [10], as well as Choi's paper on the effect of converters [6] on technology adoption.

## IPv6

There are a number of academic papers on the transition to IPv6. For a great accessible overview, read Ben Edleman's article [7]. I also found Geoff Huston's column on why the IPv6 transition may be a market failure [15] to be very helpful, although the target audience for this article is network researchers and network operators, rather than economists.

For statistics on IPv4 exhaustion, see Huston's website http://www.potaroo.net/tools/ipv4/ index.html. There have been many studies on the status of IPv6 adoption. See [19] for some references, or visit this page to see adoption from Google's vantage point http://www.google.com/ intl/en/ipv6/statistics/.

For academic work on the transition to IPv6, I mentioned these papers by Guerin et. al [13, 24]. There are also other interesting works in this space including [16, 21].

On IPv4 address auctions, the only work thus far is this work by Edelman and Schwarz on IPv4 address auctions [8]. It's also very interesting to read this social science paper on the apprehension network operators feel about moving towards address auctions [14].

## **Routing Security**

For an overview of the technical problems of adopting routing security, see this survey [4]. For academic work on the problem of adopting secure routing protocols, I talked about my own work [11, 12]; there is also some other work from the networking community on this topic, including [5, 1].

## References

- [1] I. Avramopoulos, M. Suchara, and J. Rexford. How small groups can secure interdomain routing. *Princeton University Computer Science Department, Tech. Rep. TR-808-07*, 2007.
- [2] F.M. Bass. A new product growth model for consumer durables. *Management Science*, pages 215–27, 1969.

- [3] F.M. Bass. Comments on" a new product growth for model consumer durables": The bass model. *Management science*, pages 1833–1840, 2004.
- [4] K. Butler, T.R. Farley, P. McDaniel, and J. Rexford. A survey of bgp security issues and solutions. *Proceedings of the IEEE*, 98(1):100–122, 2010.
- [5] H. Chan, D. Dash, A. Perrig, and H. Zhang. Modeling adoptability of secure BGP protocol, volume 36. ACM, 2006.
- [6] J.P. Choi. Do converters facilitate the transition to a new incompatible technology? a dynamic analysis of converters. *International Journal of Industrial Organization*, 14(6):825–835, 1996.
- [7] B. Edelman. Running out of numbers: Scarcity of ip addresses and what to do about it. Auctions, Market Mechanisms and Their Applications, pages 95–106, 2009.
- [8] B. Edelman and M. Schwarz. Pricing and efficiency in the market for ip addresses.
- [9] J. Farrell and G. Saloner. Standardization, compatibility, and innovation. *The RAND Journal of Economics*, pages 70–83, 1985.
- [10] J. Farrell and G. Saloner. Installed base and compatibility: Innovation, product preannouncements, and predation. *The American Economic Review*, pages 940–955, 1986.
- [11] P. Gill, M. Schapira, and S. Goldberg. Let the market drive deployment: A strategy for transitioning to bgp security. In *Proceedings of the ACM SIGCOMM 2011 conference on* SIGCOMM, pages 14–25. ACM, 2011.
- [12] S. Goldberg and Z. Liu. Technology diffusion in communication networks. Arxiv preprint arXiv:1202.2928, 2012.
- [13] R. Guérin and K. Hosanagar. Fostering ipv6 migration through network quality differentials. ACM SIGCOMM Computer Communication Review, 40(3):17–25, 2010.
- [14] J. Hofmann. Before the sky falls down: A constitutional dialogueover the depletion of internet addresses.
- [15] Geoff Huston. The isp column: Is the transition to ipv6 a "market failure?". http://www. potaroo.net/ispcol/2009-09/v6trans.pdf, 2009.
- [16] Y. Jin, S. Sen, R. Guérin, K. Hosanagar, and Z.L. Zhang. Dynamics of competition between incumbent and emerging network technologies. In *Proceedings of the 3rd international workshop* on *Economics of networked systems*, pages 49–54. ACM, 2008.
- [17] M.L. Katz and C. Shapiro. Network externalities, competition, and compatibility. The American economic review, 75(3):424–440, 1985.
- [18] V. Mahajan, E. Muller, and F.M. Bass. New product diffusion models in marketing: A review and directions for research. *The Journal of Marketing*, pages 1–26, 1990.
- [19] M. Nikkhah, R. Guérin, Y. Lee, and R. Woundy. Assessing ipv6 through web access a measurement study and its findings. In *Proceedings of the Seventh Conference on emerging Networking EXperiments and Technologies*, page 26. ACM, 2011.

- [20] J.A. Norton and F.M. Bass. A diffusion theory model of adoption and substitution for successive generations of high-technology products. *Management Science*, pages 1069–1086, 1987.
- [21] S. Ratnasamy, S. Shenker, and S. McCanne. Towards an evolvable internet architecture. In ACM SIGCOMM Computer Communication Review, volume 35, pages 313–324. ACM, 2005.
- [22] E.M. Rogers. *Diffusion of innovations*. Free Press, 2003.
- [23] M. Rysman. The economics of two-sided markets. *The Journal of Economic Perspectives*, 23(3):125–143, 2009.
- [24] S. Sen, Y. Jin, R. Guérin, and K. Hosanagar. Modeling the dynamics of network technology adoption and the role of converters. *IEEE/ACM Transactions on Networking (TON)*, 18(6):1793–1805, 2010.
- [25] Arun Sundararajan. Network effects. http://oz.stern.nyu.edu/io/network.html, 2003-6.